DECIPHERMENT OF BLURRED FINGER PRINTS

FRANCIS GALTON

2. G. 87.

the Directors Jubilee 1895.

SUPPLEMENTARY CHAPTER TO 'FINGER PRINTS'

DECIPHERMENT

OF

BLURRED FINGER PRINTS

BY

FRANCIS GALTON, F.R.S., ETC.

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DECIPHERMENT OF BLURRED FINGER PRINTS

The registration of finger prints of criminals, as a means of future identification, has been thought by some to be of questionable value on two grounds—first, that ordinary officials would fail to take them with sufficient sharpness to be of use; secondly, that no jury would convict on finger-print evidence. These objections deserve discussion, and would perhaps by themselves have justified a supplementary chapter to my book. It happens, however, that there are strong concurrent reasons for writing it. I have lately come into possession of the impressions of the fore and middle fingers of the right hand of eight different persons, made by ordinary officials, in the first instance in the year 1878 and secondly in 1892. They not only supply a text for discussing both of the above objections, but they also afford new evidence of the persistence of the *minutiæ*, that is of the forks, islands, and enclosures, found in the capillary ridges. It will be recollected that the evidence of their persistence, published or alluded to in my book, was derived from impressions made by only fifteen different persons, at the beginning and end of considerable intervals of

time, varying from twelve to thirty-one years. Consequently, the data that have been derived from eight other persons well deserve to be recorded.

The question now before us has nothing to do with classification, but is merely this: would such impressions as ordinary officials are likely to take, afford evidence strong enough to convince a jury that two submitted finger prints had or had not been made by the same finger? It is, of course, supposed that the cogency of the finger-print argument will be presented to the jury in that lucid and complete form in which it is the business of barristers to state and support their case, when they are satisfied of the integrity of the evidence on which it is based.

The following paragraph occurs in *Finger Prints* (p. 89): "It would be well worth while to hunt up and take the present finger prints of such of the Hindoos as may now be alive, whose impressions were taken in India by the instructions of Sir W. J. Herschel, and are now preserved."

Sir William thereupon was so good as to write privately to Mr. Cotton, Secretary to the Government in Bengal, explaining more particularly what was wanted and where to look for it. The result has been that a letter or memorandum was received by him from Mr. Duke, the present Joint Magistrate of Hooghly, forwarding a batch of authenticated impressions. Mr. Duke remarks in it that all persons who executed documents, and registered them in the Hooghly Registration Office in the year 1878, were

made to give impressions of the fore and middle fingers of their right hands in a separate book kept for that purpose, and that although the practice has been discontinued, the book of impressions has been preserved. He caused the Register of the Deeds executed in that year to be searched for the names of persons who were still alive and resident at or near Hooghly, when it was found that the number of those who fulfilled both conditions was small. The Special Sub-Registrar of Hooghly, Babu Ram Gati Bannerjee, was then asked to visit eight of these persons (I do not know how many more were available), and to take fresh impressions of their fingers. He was so good as to do so with much care, impressing them successively on the same sheet of paper, and adding to each the name, age (actual or estimated), and date. Not only did he do this, but having been also given slips, cut out of the book that contained the original finger prints, he took a new impression on each slip by the side of the old one. Thus a collection was formed of impressions of the fore and middle fingers of eight different persons, one set in each case having been made in 1878, and two sets in each case having been made in 1892. (Some details were added in the accompanying notes concerning the impressions, that are not worth recording here.) All these were sent to Sir W. Herschel, and have been made over by him to me, and are now in my possession. The documents are characteristically Oriental; they are on a common kind of apparently native-made paper, worm-eaten with many holes, and abundantly subscribed with

attestations, names, ages, and dates, partly written in English and partly in native characters. They refer to the persons in the following list. The numbers in the first column are those of the Deeds executed in 1878 by each of the persons whose finger prints form the collection in question.

	1878. No. of Deed.	In 1892. Age (about).
I. Saburan Bibi . .	162	65
II. Dwārikā Nath Banerji .	28	64
III. Girish Chandra Rāy .	43	52
IV. Bechā Rām Dās Adhikari	22	42
V. Sri Nāth Set . .	51	62
VI. Gagan Set . . .	58	52
VII. Mādhab Chandra Rāy .	54-56	54
VIII. Ghirish Chandra Pandit .	379	46

My heartiest thanks are due, and are here gratefully rendered, to all the persons who have contributed to put me into the possession of such interesting materials.

The only thing that I cannot commend is the method of printing, which is by using dye or water-colour. It is very difficult in that way to ensure good impressions, because if the blackened pad on which the finger is pressed be wet or even moist, instead of being merely damp, the dye fills the furrows as well as the ridges; the finger is blackened all over, and on being pressed on paper it leaves a blot. Though the pad be in good order, a finger that is damp with its own perspiration will similarly make a blur or blot. Moreover the *grain* of a pad is too coarse for fine printing.

The impressions obtained from these eight persons cannot compare in clearness with those regularly and rapidly taken in large numbers at my laboratory by means of printer's ink, in the way fully described in Chapter III. of *Finger Prints*. The ink is spread uniformly and *very thinly* on a smooth slab by a printer's roller, the fingers are pressed on this and then on paper, and the results are uniformly of a high-level order of goodness. If the fingers are wet with perspiration they should be dried first with a rag. I do not overlook the fact that much of the indistinctness of the Hooghly impressions is due to disintegration of the skin, owing to the advanced ages of the persons in 1892 (*op. cit.* 58). Three of the eight persons were then more than sixty years old, and three more of them were over fifty, which I presume corresponds to greater ages among ourselves, since Indian children are more precocious than ours. Neither should the fact be forgotten that hard manual labour of certain kinds may injure the sharpness of the ridges (p. 59). Nevertheless, after making full allowance for these two causes, there remains a large amount of indistinctness which is unquestionably due to what experience has convinced me to be a faulty method of printing, and by no means to lack of adequate skill or zeal in the officials.

The practice of always taking the impression of a single digit of criminals is, I understand, now under trial by the Bengal police; it is to be hoped that the trial will not be limited to the process with dye or water-colour.

These criticisms have been made principally in order to establish the points upon which this pamphlet is based. It will soon be shown how great is the value even of these blurred Hooghly prints for purposes of identification, and it is evident from what has just been said, that the value of impressions made by the method of printer's ink, but otherwise under similar conditions, would be considerably greater.

Reproduction of the Prints.—I photographed each set of fore and middle finger prints that were impressed in 1878, upon a "quarter plate," enlarging them at the same time to a two and a half scale, which was as much as the quarter plate could conveniently hold. I did the same with *the best* of the two sets of 1892. Slightly better results would have been obtained by sometimes selecting the fore finger from one of the two sets and the middle finger from the other, but the gain by doing so seemed not to be worth the trouble. These prints have been photo-lithographed, and they appear in Plates I. to IV.

Experience having convinced me of the necessity of considerably enlarging prints that are intended to be submitted to an unpractised eye, I selected a seven-fold scale for use in this book, which is none too large, because there ought to be space for legible notes and marks being written between the lines. The whole of each impression on a seven-fold scale would, however, require too many plates for publication in this pamphlet, so I selected a portion of one finger, fore or middle as the case might be, in each set, and

was contented to discard the rest. The selected portions always included the most characteristic part of the pattern, namely its core, together with that portion of the adjacent parts that seemed in each case to be most suitable. After completing the enlargements and putting the apparatus by, I found that the selected portion of No. V. was by no means the best that might have been made. In fact it could hardly be deciphered at all. It was therefore discarded altogether and its place supplied by the second of No. VII. set. Some further remarks about No. V. will be made in their place, among the rest.

Though only about half of the impression of a single finger has been discussed on the seven-fold scale, it will be found that even this much, which is bounded by the sides of a rectangle 2 inches wide and $3\frac{1}{4}$ deep, ought in most cases to convince a jury. The whole of the palmar surface of the hands and of the soles of the feet contains similar material. Their total extent of surface may be taken to be 100 square inches, which on a seven-fold scale would cover forty-nine times that area, or no less than thirty-four square feet. If the Hooghly method were improved and regularly adopted, the whole of the impressions of the bulbs of each of two fingers would be available. Then, there would usually be upwards of thirty points of reference in each finger print, or of sixty points altogether. Even in these half portions of single impressions, which are far from being good, it will be seen that there are on an average between fifteen and sixteen points of reference in each.

Before comparing the 1878 and 1892 impressions in turns, it is necessary to strongly insist on a point on which great stress was laid in *Finger Prints* (p. 91, illustrated in p. 80). It concerns the particular kind of resemblance that is to be looked for. The one important point in making comparisons, is to remark the *place* where a new ridge begins to make its appearance, because the *manner* in which it seems to begin is quite secondary. A new ridge is usually connected with one or other of the ridges between which it rises, or it may be with both of them, by means of a low neck, or a *col* as mountaineers would call it. An impression of this *col* may be purely the result of using overmuch ink, or overmuch pressure. Again, after the lapse of many years, it is quite possible that the height of the *col* may have become slightly raised or depressed, and that it may be always, or else never, printed. It follows that when a fork in one finger print corresponds to the sudden appearance of a new ridge in the other, the event is to be counted as an agreement and not as a disagreement. There are several good instances of this apparent incongruity, but real agreement, in the present collection, to two or three of which the attention of the reader will be directed. I have made the practice in all these cases, of representing the *event* in both of the prints by the same symbol, whether it be a fork or a terminal circle, such as might seem most suitable to the particular case.

Confining our attention now to the prints on the

seven-fold scale, it will be seen that they are here presented in three different manners. Plates V. to VIII. are the simple untouched enlargements. In IX. to XII. these same enlargements are shown in orange, with the axes of the ridges as I have deciphered them, printed in a different and darker colour. It would be the business of a barrister to so examine an expert as to elicit the value of the decipherment in each particular. Plates XIII. to XVI. are skeleton charts; they show the axes of the ridges alone, with numbers attached to each point of reference, for facilitating comparison and explanation. The whole of the materials for forming a judgment are given here, in a shape somewhat similar to that which, I presume, would be put into the hands of each member of the jury and others concerned with the case. The set of three might be photo-lithographed as these are, but on the same sheet, or they might be submitted as ordinary photographic prints. The first set shows the original data on a seven-fold scale, the third set shows their decipherment, while the second set combines the first and the third. The numbers printed by the sides of the points of reference were not inserted in the second set, lest its general effect should be spoiled by them. When the decipherment of Plates IX. to XII. has been accepted as correct, the comparison of the skeleton charts is as simple a matter as that of two plans, drawn on the same principle and to the same scale, with the view of ascertaining whether they refer to the same district. The fact of the practically infinite variety of skeleton charts would be impressed

on the jury by the exhibition of numerous specimens. After a few causes had been tried in which finger-print evidence was adduced and commented on, this fact would become popularly accepted, and its proof would give no further trouble to the counsel.

In deciphering an impression, it is a very good plan to lay the print against a pane of the window (or on a photographic retouching frame), and to pencil the axes of its ridges on the back. Of course, tracing paper may be used, but I think the other plan is better, at least for a moderate draughtsman. There is no possible slipping of flimsy paper; the facts and their interpretation are both contained on the same sheet, one on the one side of it and the other on the other, while they do not interfere, unless the print is viewed as a transparency, in which position it might (especially if rendered temporarily transparent by a volatile oil) be so photographed as to correspond with the figures in Plates IX. to XII.

The axes should be drawn with a finely pointed pencil, and with care, down the middle of the ridges. Slap-dash attempts are almost sure to be failures. It is advisable to take pains to determine a common starting point, before beginning to draw any lines at all; then to proceed from point to point in the two prints alternately, at first with wariness but afterwards much more freely.

It is very likely that the correctness with which some of the more blotted parts of these charts have been deciphered, may be open at first to question. The absurd mistakes sometimes made by antiquaries

in their interpretation of defaced inscriptions might be quoted as a warning.

There is considerably less risk of blunder in deciphering somewhat defaced finger prints than in making out equally defaced inscriptions, the conditions to be fulfilled being more exacting. The continuous course of every line has to be made out from beginning to end, and the lines must nowhere be too crowded or too wide apart, and they must all flow in easy and appropriate curves; also as much regard must be paid to such blanks as are not obviously due to bad printing, as to the markings. The general effect of these conditions is that a mistake in deciphering any one part of the impression nearly always introduces confusion at some other part, where the lines refuse to fit in. A study of the eight doublets in succession from Plates V. to VIII., in connection with those in Plates IX. to X., is the best guarantee for the truth of these remarks.

Whoever reads these pages with a desire of thoroughly understanding the art of decipherment should practise on the Plates V. to VIII., using tracing paper for the purpose, and of course beginning with the easier prints. If he should hereafter have occasion to compare other enlargements, he will discover the necessity of orienting them alike and of carefully confining his attention to the part common to both. This has been done for him in Plates V. to VIII.

I. Fore Finger.—The print of 1892 is unfortunately of the tip rather than of the bulb of the finger, and so just fails to include four of the excellent points of reference marked with a

cross (X) in the skeleton chart of 1878. Nine of the ten points that have numbers at their sides, are clear and call for only two special remarks. No. 2 is drawn with a terminal circle to express an abrupt ending, which is the case in the print of 1878; it might with equal propriety have been drawn as a fork, according to the print of 1892. This is a good example of the ambiguity, so strongly insisted upon above, that the *manner* in which a new ridge appears to begin is of secondary importance; the primary fact to be noted is that a new ridge comes *somehow*—never mind how—into existence between two particular ridges and at a particular spot, where they have separated to permit its interpolation. No. 6 is very imperfectly shown in the 1892 impression, because it falls almost wholly outside its limits; it is consequently not counted. The existence of a fork at that place is easily verified by turning to the ampler impression, on a smaller scale, in Plate I.

Total.—Nine points of agreement; none of disagreement.

II. Middle Finger.—This is a striking example of the possibility of deciphering under great difficulties. Three points of reference in the print of 1878 could alone be seized upon as being more or less dependable; they were the summit of the innermost loop 5, as determined by the central furrow, and the enclosure 6, 7, whose blurred mass in the 1878 print has an outline fairly similar to that of the well-marked enclosure in the print of 1892. The blur is distinctly separated from the next ridge outwards, and indistinctly but sufficiently from the next ridge inwards, and its central furrow is faintly indicated.

Starting from 5, 6, and 7, the bifurcations 2 and 3 were clearly made out. Nothing more can be said in favour of 1, 4, and 8 than that they are congruous with those of the 1892 print in width and position; they are too much blotted to afford further evidence, and will not be counted at all.

Total.—8 less 3, or 5 points of agreement; none of disagreement.

III. Middle Finger.—There is abundant evidence in this case of the identity of the finger that impressed the two prints. The cross (X) indicates that a fork in the 1878 print does not fall within the limits of the seven-fold enlargement of the portion of 1892. The finger had become broader in the interval. The

fork is clearly seen in the ampler but less enlarged impression in Plate II. No. 6 in the 1878 print falls in the middle of a worm-eaten hole in the original paper, but the accident is of little importance, because the hole is small, and a ridge that is clearly seen to come out of its boundary has not entered it from the other side; consequently it begins somewhere within the limits of the hole, either as a fork or else suddenly, as is here drawn in order to correspond with the skeleton chart of 1892. Owing to the badness of the 1892 impression a novice might be puzzled to decipher the core, but there are so many clear points of agreement between the two prints that by taking, say, Nos. 16, 8, and 15 as three independent starting points, it is impossible to go wrong.

Total.—Twenty-one points of agreement; none of disagreement.

IV. Fore Finger.—Here the results are most satisfactory, though owing to one cause or another it gave me a little trouble to decipher the core. The persistence of the small scar made by a cut is interesting, as is also the good example it affords of the small difficulty caused by a deep cut in determining the original connections between the ridges that it severed and permanently dislocated.

Total.—Nineteen points of agreement; none of disagreement.

(V.) Though no seven-fold enlargement is given of either of the two fingers in this case, for reasons mentioned at p. 7, it will be well to turn to Plate III. and to study the minutiæ found at the base of the print of the middle finger. Place a card over the left part of the 1892 impression, so as to cut off the part of it that does not appear in the impression of 1878. Three points of reference, at least, will be easily made out, and should be used as starting points for further analysis. The upper portion of the impression of 1892 is very troublesome; still, I can trace a few points of apparent incongruity, though unable to rely on any one of them. The whole of the 1892 impression of the fore finger is equally difficult to analyse. The badness of the print is here mainly due to disintegration through age, and probably through hard manual labour also. The person who made it, is stated to have been sixty-two years old.

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VI. Fore Finger.—All the seven points of reference are distinctly seen in both prints. No. 1, in the print of 1892, is an excellent instance of the ambiguity caused by bad printing, as to the manner in which a new ridge really begins, although the fact of its beginning at a particular place is certain. In this instance there is nothing to tell whether it commences as a fork of the upper ridge, or of the lower ridge, or if it is connected with both, or whether it has an altogether independent origin.

Total.—Seven points of agreement; none of disagreement.

VII. Fore Finger.—The markings are very characteristic in this case, and the points of reference are numerous; they are totally different from those in II. middle finger and V. fore finger, though the *patterns* of all three finger prints have much the same general appearance. The island marked 5, 6, is not trustworthy; it is worth remarking, but is not intended to be counted one way or the other. On the other hand, there are two small and interesting islands, 14, 19, which not only should be counted, but should each of them be marked with two numbers, one for its beginning and one for its end. The subtraction of two numbers in the first case, and the addition of two in the second, leaves the total number of points of reference the same as the highest number that is recorded, viz. 19.

Total.—Nineteen points of agreement; none of disagreement.

VII. Middle Finger.—This is introduced in the place of one of the set V. Its core is an example of the monkey type of lineations, and gives me the opportunity of saying that the few instances I possess of prints of this type were taken from persons who did *not* seem to be of low or degenerated organisation. One of my specimens is taken from the finger of a lady who strikes me as being both physically and intellectually considerably above the average of her sex.

Total.—Fifteen points of agreement; none of disagreement.

VIII. Fore Finger.—The disintegrated lineations of 1892 were a little difficult to unravel, but the whole has been effected satisfactorily, except the hopelessly broken portion between 5 and 6. Of these, 5 has no value as evidence of identity; it is merely inserted for convenience of explanation and is not intended to be counted. The two ridges that issue from 9 seem to unite in the one that ends in 12, but no clear idea can

be formed from either print of the ending of the ridge that issues from 8.

Total.—Thirty points of agreement; none of disagreement.

SUMMARY OF POINTS OF AGREEMENT AND DISAGREEMENT BETWEEN THOSE PARTS OF THE IMPRESSIONS OF 1878 AND 1892 THAT ARE PRINTED ON A SEVEN-FOLD SCALE.

No. of the Person.	Finger printed from.	Number of points of Agreement.	Number of points of Disagreement.	Pattern.
I.	Fore	9	none	loop
II.	Middle	5	none	loop
III.	Middle	21	none	whorl
IV.	Fore	19	none	whorl
VI.	Fore	7	none	loop
VII.	Fore	19	none	loop
VII.	Middle	15	none	loop
VIII.	Fore	30	none	whorl
Total . . .		125	none	
Average. . .		15.6		

The evidence discussed thus far has been drawn from the correspondence of the minutiæ, and not of the general pattern. A few words must now be said about the latter. They are chiefly in warning. No person could possibly mistake a decided whorl for a decided loop, but lesser differences are often deceptive to an untrained eye, especially when the impression includes only a portion of the pattern. Many, for example, might hurriedly translate the "II. fore finger" in the 1892 impression as a "tented arch" instead of a loop. Until the time comes when finger prints are popularly cared for, it would require an

expert to give a trustworthy account of the patterns of imperfect and blurred impressions.

It will be recollected by those who have read *Finger Prints* that the varieties of pattern—arch, loop, whorl—found on the several ten digits of the same person goes some way, and in many cases a long way, towards identifying him. The same may be said in a lesser but still considerable degree of the patterns on the first three fingers of either hand, six in all. But when only two fingers of the right hand are taken into account, the evidence that their patterns can afford towards identification is usually small. Of course, the *negative* evidence they may give is absolutely trustworthy; thus the man who impressed I. could not possibly be the man who impressed IV.

The table in p. 132 of *Finger Prints* shows that some few combinations of patterns in these two fingers are rare, so the evidence that an occurrence of those combinations could give, would be proportionately strong. Using the notation of that table, we see that in 100 cases there was no occurrence of *ao*, *ia*, *io*, *oo*, *ow*, *wa*, or *wo*, and only one occurrence of *oa*.

A few words should be added on the recent considerable experience I have had in photographing finger prints. Mawson's photo-mechanical plates are the only ones that have given satisfactory density, being especially made for the reproduction of black and white drawings of mechanism. If an enlarged print is wanted hurriedly, and the light is not good, the best economy of time is to take a negative of the same size as the original, and to use it as a trans-

parency to enlarge from, on paper, in the camera. A seven-fold enlargement direct from a print is a very tedious operation in the wintry daylight of London. If the person be accessible from whom an enlarged impression is wanted, the inked or smoked glass, from which his finger has been blackened, affords a transparent negative for use in the camera. Should it be the intention to store the negative, recollect that a glass inked with printer's ink takes some two or three days to dry hard, and that when dried hard it is liable to no injury from rough packing, but *it will not bear water*. It is curious to notice how quickly water will find its way between dried printer's ink and the glass, and detach it. Consequently ink negatives that are intended for storing had better be varnished; those on smoked glass must be varnished also. Of course no varnish is needed before using them in the camera. The negatives can be enlarged immediately after the finger has been raised from the blackened glass.

A camera that shall enlarge to any uniform scale, or even to one or other of two or three alternate scales, is most easily made by fitting a box or boxes to the body of a camera. I worked for some time with a home-made apparatus of this sort, of a very rude kind. In the apparatus I now use the print is adjusted to a frame, removable from the camera, under the guidance of a card that can be dropped into a recess in the middle of the frame, which it neatly fits. The card has a rectangular hole in its middle that exactly defines the portion of the print that will fall within the limits of the photograph.

After the adjustment is completed the print is clamped, the card is removed, and the frame is replaced on the camera. It fits into its place with accuracy, and is clamped there. The desired portion of the print is then sure to occupy the proper position in front of the lens. I often photograph many prints in succession without caring to verify either the focusing or the adjustment, having found that there is rarely any sensible error.

Photographic enlargements save a great deal of petty trouble. It is far easier to deal exhaustively with them than it is with actual impressions viewed under a magnifying glass. In the latter case, a few marked correspondences, or the reverse, can readily be picked out, and perhaps noted by the prick of a fine needle, the point of a pin being much too coarse. It is thus easy to make out whether a suspicious print deserves the trouble of photographic enlargement, but without previous enlargement a *thorough* comparison between two prints is difficult even to an expert, and no average juryman could be expected to make it.

Printed by R. & R. Clark, *Edinburgh.*

I.—Fore. 1878.

I.—Middle.

II.—Fore. 1878.

II.—Middle.

I.—Fore. 1892.

I.—Middle.

II.—Fore. 1892.

II.—Middle.

III.—Fore.

1878.

III.—Middle.

IV.—Fore.

1878.

IV.—Middle.

III.—Fore.

1892.

III.—Middle.

IV.—Fore.

1892.

IV.—Middle.

V.—Fore.

1878.

V.—Middle.

VII.—Fore.

1878.

VII.—Middle.

V.—Fore.

1892.

V.—Middle.

VII.—Fore.

1892.

VII.—Middle.

FORE AND MIDDLE FINGERS OF PERSONS AT HOOGHLY, BENGAL, taken first in 1878, and afterwards in 1892. Enlarged 2½ times. PLATE IV.

VI.—Fore. 1878.

VI.—Middle. 1878.

VIII.—Fore. 1878.

VIII.—Middle. 1878.

VI.—Fore. 1892.

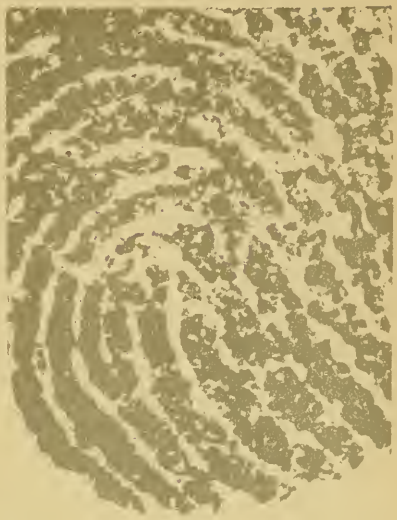
VI.—Middle. 1892.

VIII.—Fore. 1892.

VIII.—Middle. 1892.

CORRESPONDING PORTIONS OF THE HOOGHLY DOUBLETS, 1878 and 1892, enlarged seven times. PLATE V.

I.—Fore. 1878.



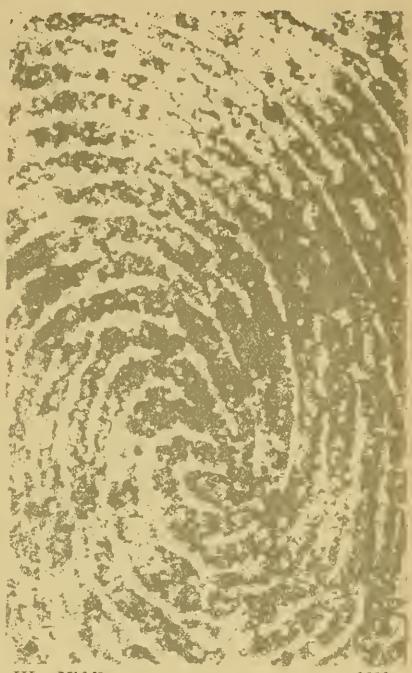
I.—Fore. 1892.

II.—Middle. 1878.

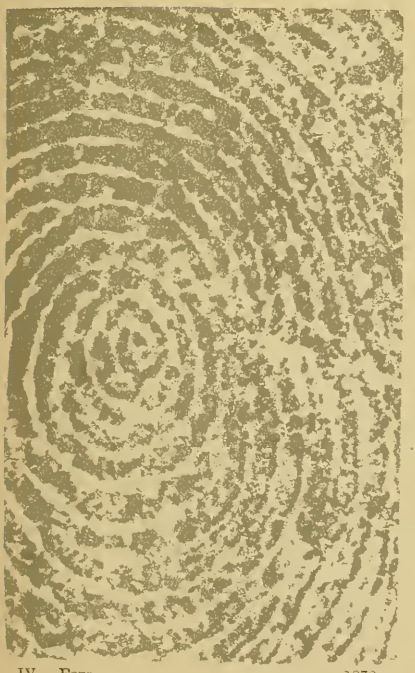
II.—Middle. 1892.

CORRESPONDING PORTIONS OF THE HOOGHLY DOUBLETS, 1878 and 1892, enlarged seven times.

III.—Middle. 1878.



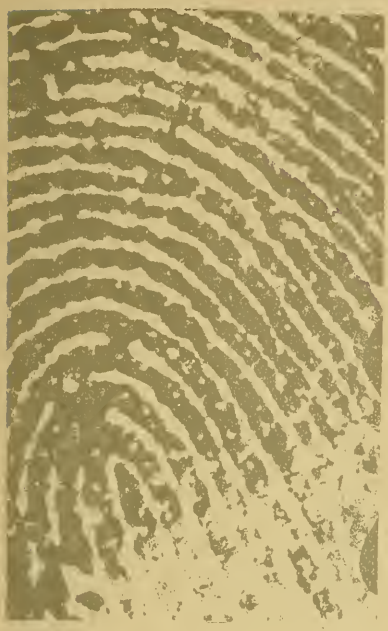
III.—Middle. 1892.



IV.—Fore. 1878.

IV.—Fore. 1892.

CORRESPONDING PORTIONS OF THE HOOGHLY DOUBLETS, 1878 and 1892, enlarged seven times. PLATE VII.



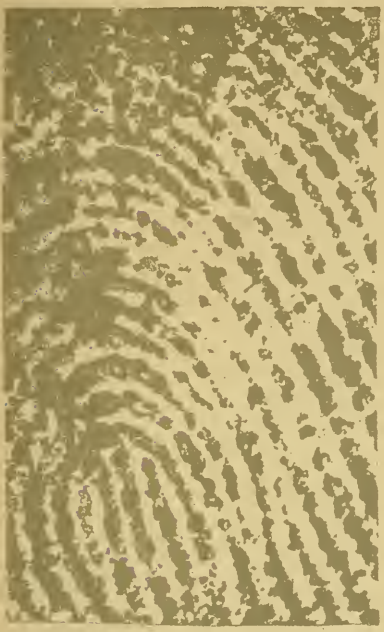
VI.—Fore. 1878.

VI.—Fore. 1892.

VII.—Fore. 1878.

VII.—Fore. 1892.

CORRESPONDING PORTIONS OF THE HOOGHLY DOUBLETS, 1878 and 1892,
enlarged seven times.



VII.—Middle. 1878.

VII.—Middle. 1892.

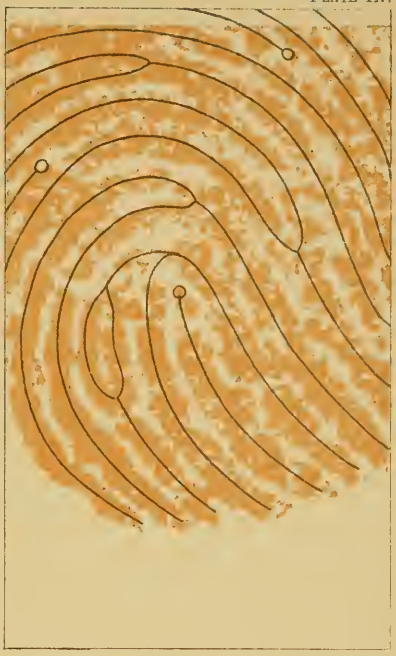
VIII.—Fore. 1878.

VIII.—Fore. 1892.

CORRESPONDING PORTIONS OF THE HOOGHLY DOUBLETS, 1878 and 1892.
enlarged seven times. Also the AXES of the RIDGES.

PLATE IX.

I.—Fore. 1878.



I.—Fore. 1892.

II.—Middle. 1878.

II.—Middle. 1892

CORRESPONDING PORTIONS OF THE HOOGHLY DOUBLETS, 1878 and 1892, enlarged seven times. Also the AXES of the RIDGES.

PLATE X.

III.—Middle. 1878.

III.—Middle. 1892.

IV.—Fore. 1878.

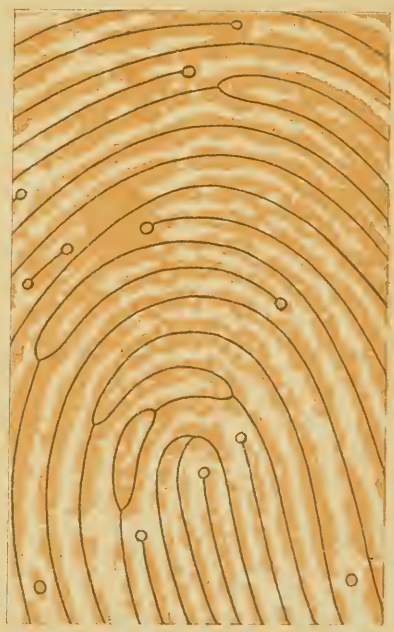
IV.—Fore. 1892.

CORRESPONDING PORTIONS OF THE HOOGHLY DOUBLETS, 1878 and 1892, enlarged seven times. Also the AXES of the RIDGES.

VI.—Fore. 1878.

VI.—Fore. 1892.

VII.—Fore. 1878.



VII.—Fore 1892.

CORRESPONDING PORTIONS OF THE HOOGHLY DOUBLETS, 1878 and 1892, enlarged seven times. Also the AXES of the RIDGES.

VII.—Middle. 1878.

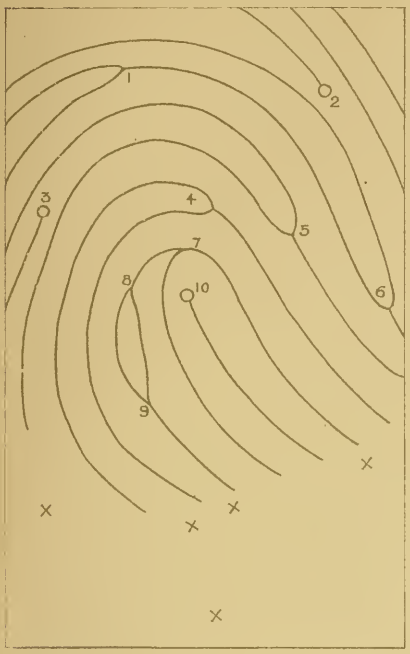
VII.—Middle. 1892.

VIII.—Fore. 1878.

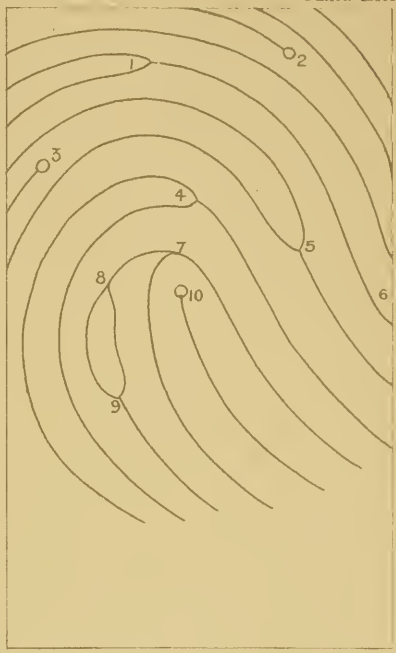
VIII.—Fore. 1892.

SKELETON CHARTS OF THE HOOGHLY DOUBLETS, 1878 and 1892, showing the Axes of the Ridges. The Points of Reference are numbered.

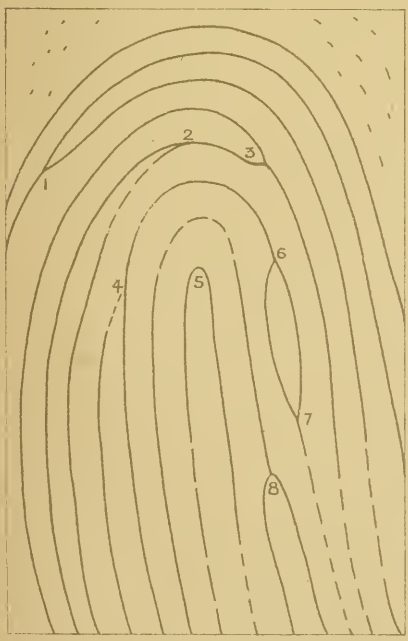
PLATE XIII.



I.—Fore. 1878.



I.—Fore. 1892.



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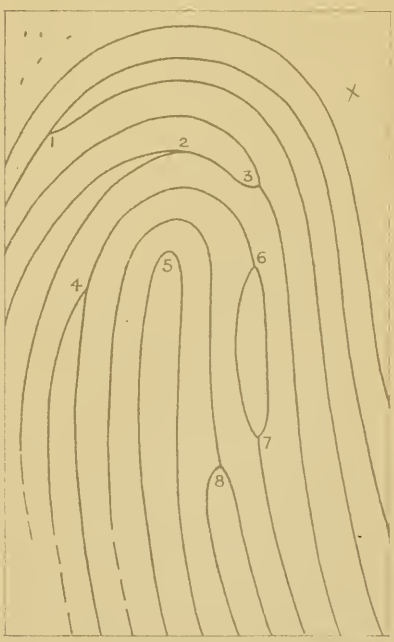
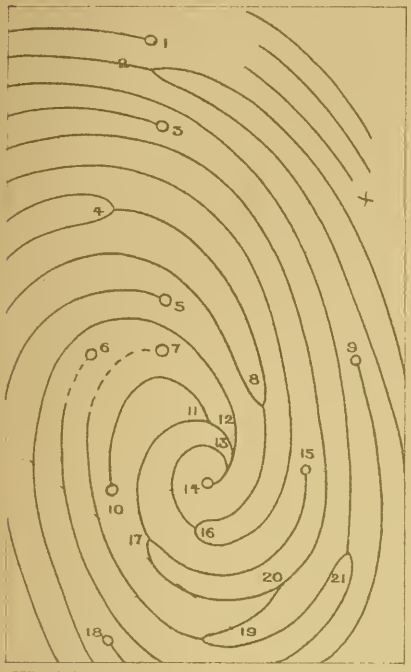


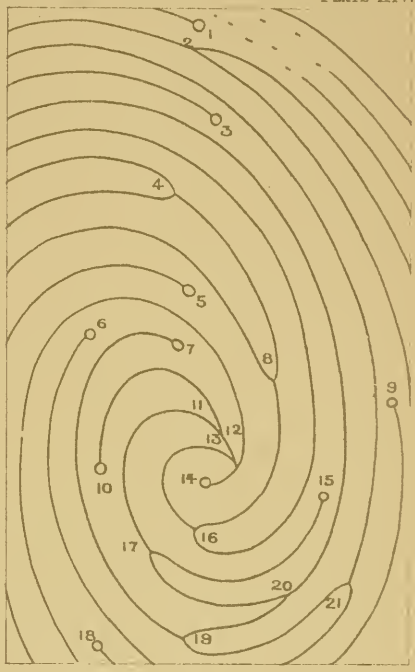
II.—Middle. 1892

SKELETON CHARTS OF THE HOOGHLY DOUBLETS, 1878 and 1892, showing the Axes of the RIDGES. The POINTS OF REFERENCE are numbered.

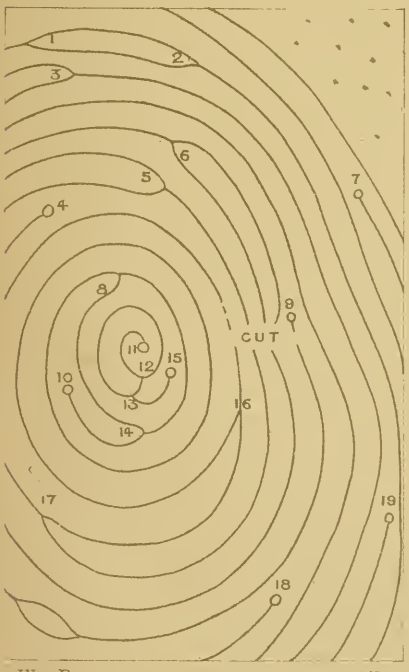
PLATE XIV.



III.—Middle. 1878.



III.—Middle. 1892.



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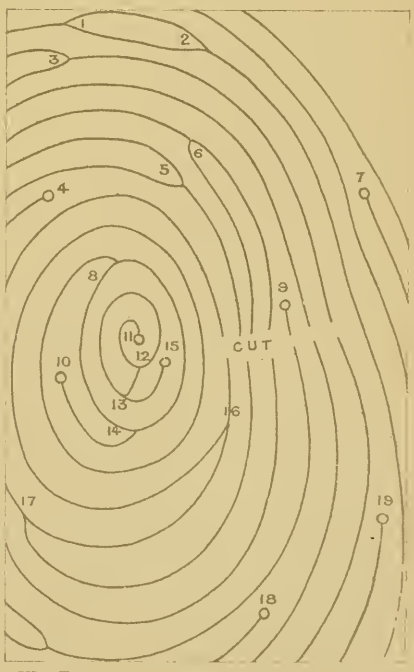
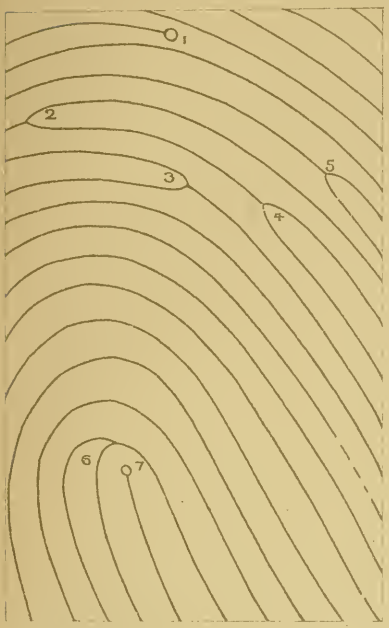
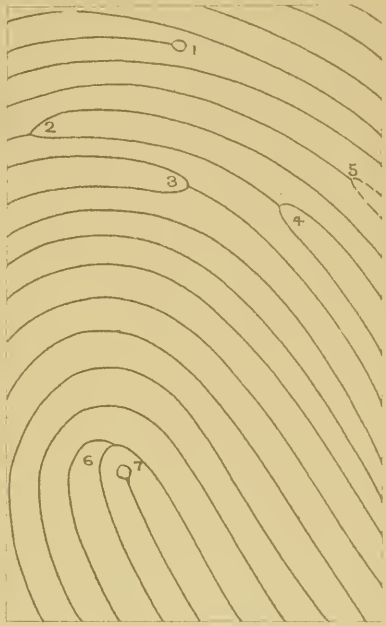


IV.—Fore. 1892.

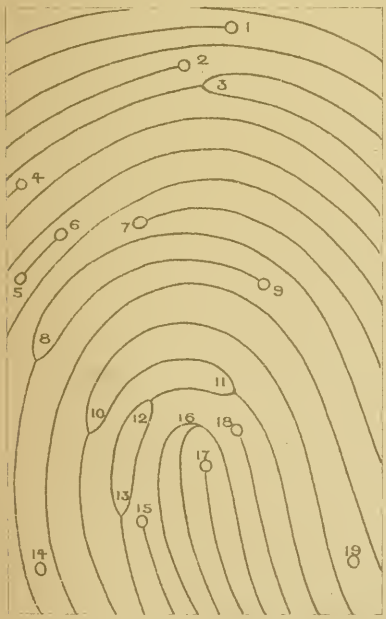
SKELETON CHARTS OF THE HOOGHLY DOUBLETS, 1878 and 1892, showing the Axes of the Ridges. The Points of Reference are numbered.



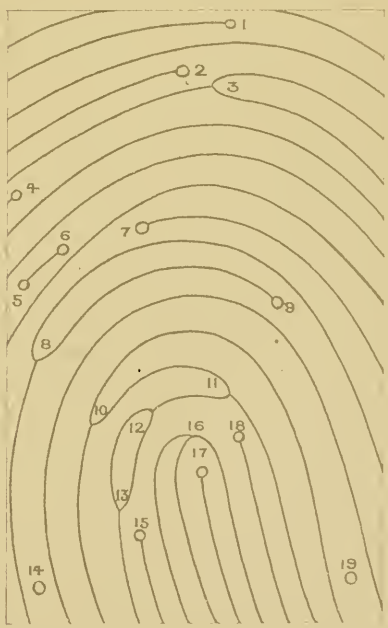
VI.—Fore. 1878.



VI.—Fore. 1892.



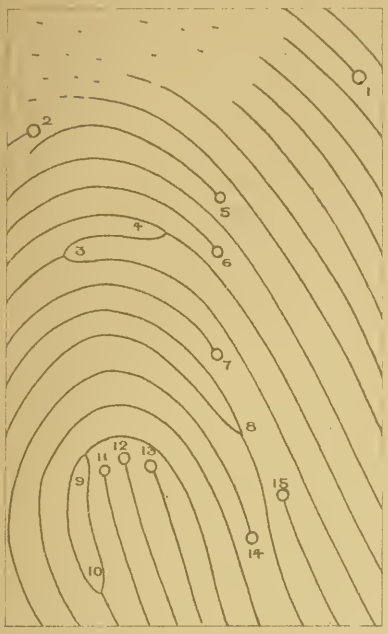
VII.—Fore. 1878.



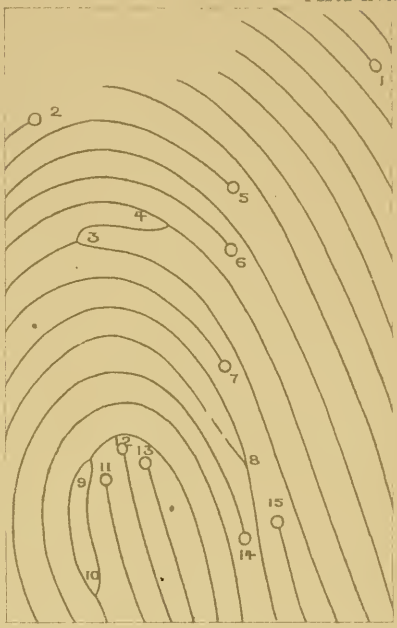
VII.—Fore 1892.

SKELETON CHARTS OF THE HOOGHLY DOUBLETS, 1878 and 1892, showing the Axes of the Ridges. The Points of Reference are numbered.

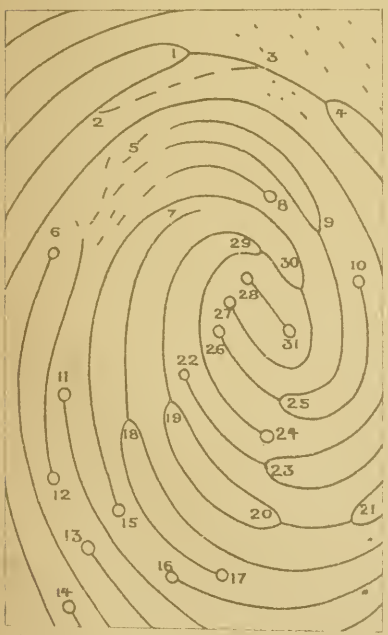
PLATE XVI.



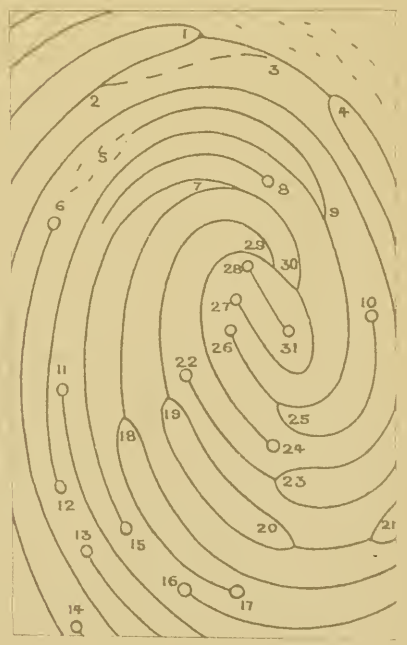
VII.—Middle. 1878.



VII.—Middle. 1892.



VIII.—Fore. 1878.



VIII.—Fore. 1892.

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